

NOAA Data Report ERL GLERL-12



LAKE ST. CLAIR AND ST. CLAIR AND DETROIT RIVERS
CHEMICAL AND PHYSICAL CHARACTERISTICS DATA FOR 1974

Gerald L. Bell

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Ann Arbor, Michigan
January 1980

Data available on microfiche
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NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION

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NATIONAL OCEANIC AND
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Gerald L. Bell

Water samples at standard depths, bottom sediment, and meteorological data were collected in Lake St. Clair and in the St. Clair and Detroit Rivers at established stations in the course of nine lake and river cruises during the 1974 open-water season. The sampling program and analytical methods are described. Chemical characteristics of the water and bottom sediment are listed by cruise for each station and sampling depth. Wind, wave, and sediment data are listed by cruise for each station. The statistical summaries showing lake-wide means, standard deviations, and sample sizes of selected variables are presented by depth for each cruise period.

1. INTRODUCTION

This basic data report presents data collected aboard the Research Vessel *Shenelon* between 22 May and 14 November 1974 in Lake St. Clair and in the St. Clair and Detroit Rivers by the Water Characteristics Branch of the Lake Survey Center and the Great Lakes Environmental Research Laboratory (GLERL), U.S. Department of Commerce, NOAA. On 25 April GLERL was formed by combining the IFYGL Project Office and the Limnology and Computer Divisions of the Lake Survey Center and transferring these units within NOAA from the National Ocean Survey to the Environmental Research Laboratories.

Data was collected systematically so that the vertical and lateral distribution of the chemical and physical properties of water in Lake St. Clair and the St. Clair and Detroit Rivers, as well as their variations with respect to time, were measured and analyzed. The project was designed to complement existing data and continuing programs in this connecting waterway between Lakes Huron and Erie and to provide the basic data which are necessary aids for optimum management of the Lakes.

As part of the 1972 International Great Lakes Water Quality Agreement between the United States and Canada, it was suggested that the International Joint Commission (IJC) study the pollution problems of Lakes Superior and Huron, especially as they relate to boundary waters and make recommendations based on the findings. As a contribution to that study, discharge from those lakes through the waterway into the lower lakes was assessed (Great Lakes Environmental Research Laboratory, 1975).

Interpretations of the data are not within the scope of this report and will be presented in subsequent publications. Meteorological

Table 1. Station Locations in Lake St. Clair and the St. Clair and Detroit Rivers During 1974 (by Latitude and Longitude)

Station	Latitude	Longitude	Station	Latitude	Longitude
1	42.056°N	83.178°W	53	42.380°N	82.580°W
2	42.056°N	83.167°W	54	42.350°N	82.510°W
3	42.056°N	83.160°W	55	42.327°N	82.462°W
4	42.057°N	83.153°W	551	42.318°N	82.475°W
5	42.057°N	83.135°W	552	42.321°N	82.456°W
6	42.057°N	83.133°W	553	42.336°N	82.446°W
7	42.057°N	83.129°W	554	42.318°N	82.453°W
8	42.057°N	83.126°W	56	42.520°N	82.860°W
9	42.293°N	83.098°W	57	42.390°N	82.450°W
10	42.293°N	83.096°W	58	42.519°N	82.688°W
11	42.292°N	83.095°W	59	42.480°N	82.620°W
12	42.291°N	83.092°W	60	42.480°N	82.570°W
13	42.291°N	83.091°W	61	42.460°N	82.540°W
14	42.357°N	82.930°W	62	42.460°N	82.460°W
15	42.356°N	82.929°W	63	42.549°N	82.599°W
16	42.354°N	82.928°W	64	42.548°N	82.598°W
17	42.352°N	82.927°W	65	42.547°N	82.598°W
18	42.351°N	82.926°W	66	42.543°N	82.584°W
19	42.343°N	82.928°W	67	42.544°N	82.584°W
20	42.341°N	82.928°W	68	42.631°N	82.633°W
21	42.340°N	82.928°W	69	42.630°N	82.633°W
22	42.380°N	82.900°W	70	42.628°N	82.633°W
23	42.366°N	82.898°W	71	42.594°N	82.633°W
24	42.350°N	82.900°W	72	42.593°N	82.633°W
25	42.340°N	82.890°W	73	42.592°N	82.633°W
26	42.330°N	82.840°W	74	42.585°N	82.556°W
27	42.350°N	82.850°W	75	42.585°N	82.555°W
28	42.370°N	82.860°W	76	42.584°N	82.553°W
29	42.389°N	82.865°W	77	42.633°N	82.488°W
30	42.397°N	82.875°W	78	42.632°N	82.489°W
31	42.403°N	82.881°W	79	42.656°N	82.514°W
32	42.476°N	82.857°W	80	42.656°N	82.512°W
33	42.450°N	82.830°W	81	42.656°N	82.510°W
34	42.430°N	82.803°W	82	42.656°N	82.508°W
35	42.400°N	82.780°W	83	42.656°N	82.507°W
36	42.380°N	82.770°W	84	42.775°N	82.472°W
37	42.350°N	82.750°W	85	42.775°N	82.470°W
38	42.320°N	82.730°W	86	42.775°N	82.469°W
39	42.301°N	82.710°W	87	42.775°N	82.468°W
40	42.640°N	82.740°W	88	42.775°N	82.467°W
41	42.620°N	82.740°W	89	42.980°N	82.420°W
42	42.610°N	82.740°W	90	42.980°N	82.419°W
43	42.594°N	82.763°W	91	42.981°N	82.417°W
44	42.600°N	82.740°W	92	42.981°N	82.416°W
45	42.600°N	82.720°W	93	42.982°N	82.415°W
46	42.580°N	82.740°W	94	43.050°N	82.450°W
47	42.560°N	82.740°W	95	43.090°N	82.410°W
48	42.540°N	82.760°W	96	43.090°N	82.290°W
49	42.500°N	82.810°W	97	43.090°N	82.210°W
50	42.465°N	82.753°W	98	43.020°N	82.340°W
51	42.440°N	82.700°W	99	42.305°N	82.778°W
52	42.410°N	82.640°W	100	42.324°N	82.562°W

conditions, as well as profiles of water temperature and transparency recorded at each station, are not included in this report.

2. METHODS

2.1 Sampling Program

Water characteristics, bottom sediment, and meteorological data were collected at 104 established stations (Figure 1, Table 1). Nine chemical cruises were made during the survey season (Table 2). A cruise is defined as the time period starting when the *Shenehon* left its home port at the Corps of Engineers Boatyard at Detroit, Mich., and ending upon completion of a survey of all stations. A full cruise normally required 10 days. The shipboard and laboratory determinations made during each cruise are summarized in Table 3.

The ship was navigated and stations were established by using a gyro compass, radar, a sextant, and visual fixes. Water sample depths were determined by a meter wheel to the nearest meter. The water depth to the bottom was determined by a Raytheon Precision Survey Fathometer, Model DE-723B, with a range of 0 to 250 in feet or fathoms and the depth presented as a graphic record on a calibrated paper chart.

Water samples were taken at each station at the surface, mid-depth and near bottom in 5-liter Niskin bottles. Very shallow stations were sampled from a 22-ft launch at the surface and near bottom. Bottom sediment samples were taken with a Shipek Sampler from the *Shenehon* and with a Ponar from the small boat.

Table 2. Cruise Schedule

Cruise	Dates
1	22 May-3 June
2 (Saginaw Bay Drogues)	
3	19 June-29 June
4	8 July-12 July (partial)
5	15 July-24 July
6	5 Aug.-15 Aug.
7	3 Sept.-7 Sept. (partial)
8	16 Sept.-25 Sept.
9	24 Oct.-1 Nov.
10	4 Nov.-14 Nov.

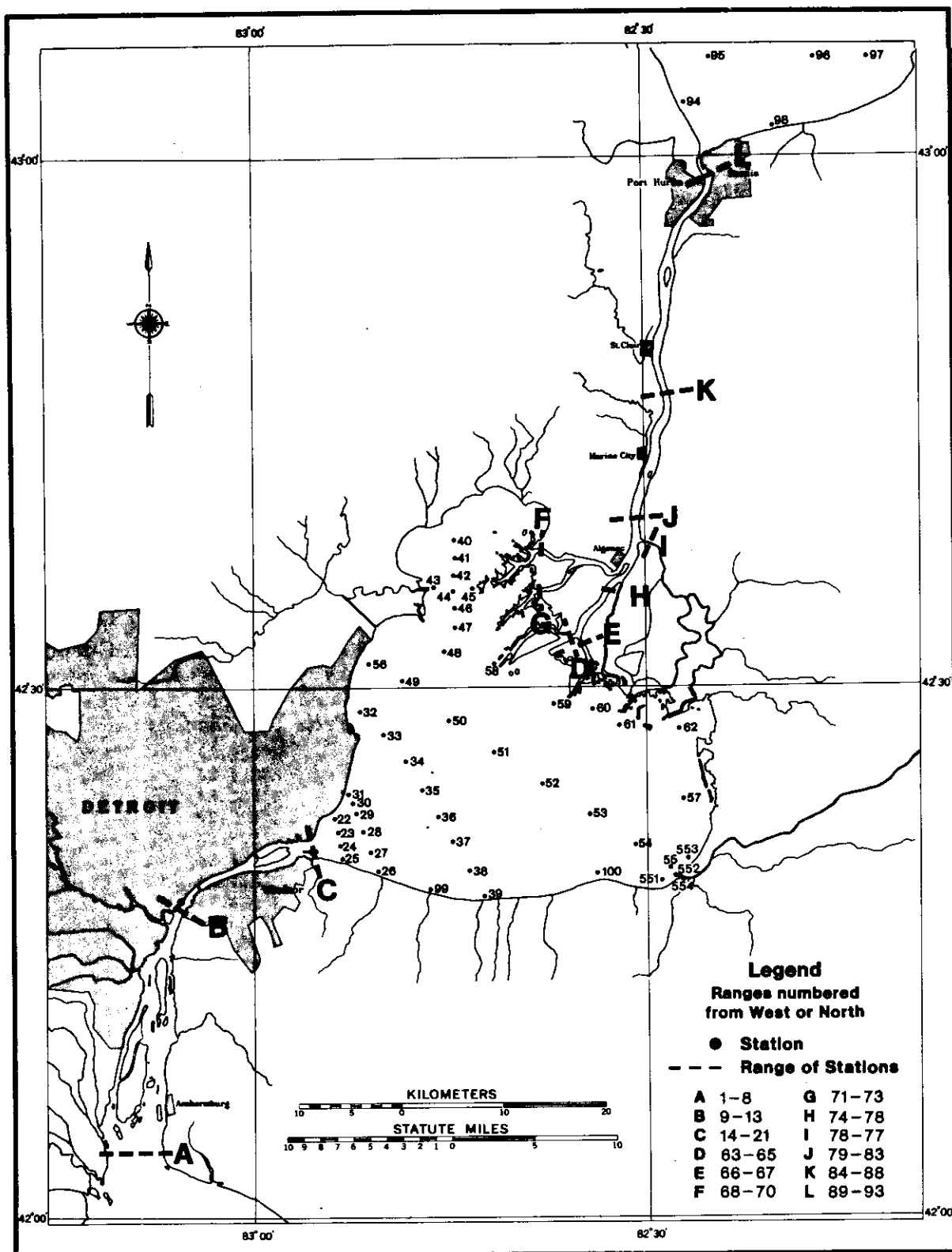


Figure 1. Station locations in Lake St. Clair and the St. Clair and Detroit Rivers during 1974.

Table 3. Shipboard and Laboratory Measurements in Connection with Limnological Studies

Shipboard Measurements

Meteorological data (printout each 6 min)

Wind speed (m/sec) (3 and 10 m above water)
 Wind direction (3 and 10 m above water)
 Barometric pressure (millibars) (3 m above water)
 Air temperature (°C) (3 and 10 m above water)
 Water temperature (1.5 m below water surface)
 Solar radiation (incident) (gram-calories per sq. cm) (10 m above water)
 Solar radiation (reflected and incident) (3 m above water)
 Relative humidity (3 m above water)
 Dew point

On station

Water

Water temperature (°C)
 Reversing thermometers at sample depth
 Electronic bathythermograph
 Air-water interface temperatures
 Transparency (relative to 100% in air)
 Secchi disc (m)
 pH
 Eh (volts)
 Total and phenolphthalein alkalinity (mg/l CaCO₃)
 Specific conductance (micromhos at 25°C)
 Dissolved oxygen (mg/l and pct. sat.)
 Coliform bacteria (membrane filter proc.)

Waves

Height (m)
 Period (sec)
 Direction (nearest 10°)

Bottom sediment

Description (physical)
 pH
 Eh

Chemistry Laboratory

Dissolved ions

Nitrate ¹	(Brucine method, A.P.H.A. ² , 1965)
Phosphate ¹	(Ammonium molybdate method, U.S.G.S. ³ , 1965)
Sulfate ¹	(Turbidimetric method, A.P.H.A. ² , 1965)
Silica ¹	(Molybdate blue method, U.S.G.S. ³ , 1960)
Magnesium ⁴	(Atomic absorption tech., P.E. ⁵ , 1971)
Calcium ⁴	(Atomic absorption tech., P.E. ⁵ , 1971)
Sodium ⁴	(Atomic absorption tech., P.E. ⁵ , 1971)
Potassium ⁴	(Atomic absorption tech., P.E. ⁵ , 1971)
Chloride	(AgNO ₃ titration)

COD (mg/l)

Suspended sediment (mg/l)

Bottom sediment

Percent solids
 Percent volatiles

¹Beckman DU-2 Spectrophotometer.

²American Public Health Association.

³U.S. Geological Survey.

⁴Perkin-Elmer Atomic Absorption Spectrophotometer.

⁵Perkin-Elmer Corporation.

Water temperatures were recorded at sampling depth to the nearest hundredth degree Celsius by protected reversing thermometers ($\pm 0.02^\circ$ accuracy) attached to each Niskin bottle. The temperature of the water circulating through the sea chest, approximately 1.5 m below the surface, was recorded to the nearest tenth degree Celsius and printed with the meteorological data at 6 min intervals. Temperature profiles were recorded at each station with a Guildline Electronic Bathythermograph, Model 1800. The bathythermograph profiles were corrected by adding or subtracting the average difference between the reversing thermometer and bathythermograph temperatures. Temperatures at small boat stations were determined by Yellow Springs Electronic Bathythermograph or bucket thermometer. Transparency measurements were made with a G.M. Mfg. and Instrument Corp. Deep-Water Turbidity Meter, Model 17-M-11, modified by the U.S. Lake Survey. Transparency was determined by relating light transmission along a 1-m path through the water to the transmission along the same path through air, expressed as a percent. Color filters were not used.

All laboratory water samples (± 475 ml) were passed through Whatman-40 filters and the weight reported with the limnological data. Large volume water samples were passed through Whatman-40 (1000-2000) and 45 micron millipore (< 1000 ml) filters to obtain the total weight of suspended materials.

Meteorological observations were recorded automatically at 0.1-hour intervals by a digital system employing solid state data gathering modules. Wind and wave observations were made while on station. The wave direction was not reported at all stations and in such cases the wind direction was used. Wave height observations are estimations. The period is based on an average time of 10 successive waves.

2.2 Chemical Analyses

The methods used in the water analysis are those described in Standard Methods (American Public Health Association, 1965), Rainwater and Thatcher (1960), Fishman and Skougstad (1965), and Perkin-Elmer Corporation (1971).

Water samples were analyzed immediately in the *Shenehon* laboratory for dissolved oxygen, specific conductance, phenolphthalein and total alkalinity, pH, Eh (oxidation-reduction potential), the pH and Eh of the interstitial water of the bottom sediment, and total coliforms.

Dissolved oxygen values were determined with a Beckman Dissolved Oxygen Analyzer, Model 777. After two separate tests were made on each sample, the highest partial pressure and the lowest sample temperature readings were used for calculating the dissolved oxygen. *In situ* temperature was recorded by the reversing thermometer at the sampling depth.

Specific conductance was measured with an Industrial Instruments Conductivity Bridge, Model RC-19. Two separate tests were made on each sample and the average expressed in micromhos at 25°C.

Phenolphthalein and total alkalinity values were determined by titrating 100-ml water samples with standard acid (H_2SO_4) to the end-points of pH 8.2 and 4.5, respectively. The end-points were determined with the pH meter and the results expressed in mg/l of calcium carbonate.

Measurements of pH and Eh were made with a Beckman Digital pH Meter, a glass pH electrode, a calomel fiber junction reference electrode, and a platinum Eh electrode. As a means of avoiding contamination, the electrodes were rinsed in a sample of the lake water to be tested. Between tests, the electrodes were immersed in distilled water. Tests of the interstitial water of the bottom sediment were made by inserting the electrodes into the sample.

Water samples to be analyzed later were preserved with chloroform and stored in 500-ml plastic bottles in a dark area below deck. These samples were transferred at the end of each cruise or survey period to the Great Lakes Research Center laboratory in Detroit.

Chloride concentrations were determined by the argentometric method and titration of a 100-ml sample of lake water. The silver nitrate was standardized and the reagent blank value determined at the beginning of each day of testing. A Beckman DU2 Spectrophotometer with flame attachment was used for analysis of nitrate, phosphate, sulfate and silica, and a Perkin-Elmer Atomic Absorption Spectrophotometer was used for calcium, magnesium, sodium, and potassium. Standard curves were constructed for each test and cruise. Tests for nitrate and phosphate were made on unfiltered samples upon arrival at the laboratory. Sample anion concentrations were determined by computer application of the absorbancy values to a standard curve that was adjusted by paired test standards run after each set of 10 to 20 samples in order to compensate for any change or drift in the spectrophotometer response. The cation concentrations were also adjusted by paired test standards and read directly from a recorder strip chart.

The bottom sediment from cruises 9 and 10 was dried overnight at 100-105°C and the weight expressed as a percentage of the wet weight. Volatiles were determined by burning at 600°C for 1 hr and reported as a percentage of the dry solids.

3. PRECISION LIMITS

The degrees of precision shown in Table 4 were determined for nitrate, phosphate, sulfate, and silica by a computer comparison of pairs of test standards to the standard curve that was used to determine the sample concentration. A pair of test standards was run after each set of 10 samples for nitrate and after each set of 20 samples for

Table 4. Measurement Precision

Variable	Units	Estimated precision	Average deviation*
Nitrate-N**	mg/l		±0.004
Phosphate-P**	mg/l		±0.0003
Sulfate	mg/l		±0.14
Silica	mg/l		±0.02
Calcium	mg/l	±0.5	
Magnesium	mg/l	±0.1	
Sodium	mg/l	±1.0	
Potassium	mg/l	±0.1	
Chloride	mg/l	±0.25	
Specific conductance	micromhos at 25°C		±1.0
Total alkalinity	mg/l CaCO ₃	±0.5	
Dissolved oxygen	mg/l	±0.1	
Dissolved oxygen	Percent sat.	±1.0	

*Average of the deviations of the test standards from the standard curve.

**Analysis of unfiltered samples which were CHCl₃ poisoned and stored for variable lengths of time.

phosphate, sulfate, and silica. Calcium, magnesium, sodium, and potassium analyses were run in sets of 10 samples followed by 1 standard and at least 1 additional standard bracketing the concentration range after each 20 samples. For both chloride and alkalinity the estimated precision is based on the change in concentration produced by one drop (0.05 ml) of titrant and that the end-point was within \pm one drop. Two readings were made on each sample for specific conductance and deviations from the mean of each pair was used to compute the average deviation. Of the 112 sample pairs randomly selected, 71 percent were within 1 micromho of the mean. The estimated precision of the dissolved oxygen determinations is based on the assumption that the partial pressure is accurate to 1 mm of mercury. The average difference in the two partial pressure readings for each sample was less than 1 mm of mercury.

Tests for nitrate and phosphate were made on unfiltered samples. From the end of a cruise to date of analysis there was an interval ranging from 1 to 4 days for phosphate and 2 to 6 days for nitrate. These samples were preserved (CHCl_3) to fix the P and N but were not refrigerated.

4. DATA PRESENTATION

The limnological data are summarized by cruise for each sampling depth at a given station (Appendix A). Nitrogen concentrations were calculated from nitrate by multiplying by a factor of 0.226. Phosphorus concentrations were calculated from phosphate by multiplying by a factor of 0.326.

The wind and wave data are summarized by cruise and station (Appendix B). Bottom sediment data, with the exception of pH and Eh, are summarized for cruises 9 and 10.

In the statistical summary, lake-wide means, standard deviations, and sample sizes are presented by depth and cruise period for selected variables (Appendix C).

5. ACKNOWLEDGMENTS

The program was formulated and directed by A. P. Pinsak. Ship services were provided by the Lake Survey Facilities Division of the National Ocean Survey. *Shenelon* operations were under the direction of R. E. Ruh through June. Lt. (jg.) F. Arbusto assumed command at the end of June.

I wish to thank the Computer Services Division for computer operations, programming assistance, and keypunching; Party Chiefs R. J. Gutleber and J. W. Gibson and staff for field operations and sample collection; J. Malczyk, A. L. Langston, and staff for laboratory analyses;

B. C. Doughty for programming and computer data reduction; J. L. Grumblatt for meteorological data reduction; W. R. Lee, D. Landay, and Lt. (jg.) D. A. Dossett of the Great Lakes Environmental Research Laboratory for assistance in data reduction; and A. Robertson and B. J. Eadie for review and suggestions. Final programming was by V. Maxey, J. Boyd, and J. Manor.

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